IES Newsletter

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Director's Note

The Institute of Ecosystem Studies makes its facilities available to visiting scholars from around the world. These scientists spend from several days to a year here, collaborating with IES ecologists, doing their own research in the laboratories or at field sites, and presenting results of their work in public programs.

In this issue of the IES Newsletter, we begin a series of articles on some of our visiting scientists by introducing Dr. Helge Leivestad from the University of Bergen, Norway. Dr. Leivestad's research is contributing to efforts to save commercially valuable salmon from the effects of acid rain.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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IES Summer, Part 2: Research for Students, Demonstrations for the Public

MICHAEL JOHN

REU students Kimberly Shaffroth, left, and Elizabeth Brozyna do a current velocity measurement around a structure that simulated woody debris in a stream.

Snails, Fish, and. . .

Elizabeth Brozyna and Kimberly Shaffroth are college students interested in careers in ecology and conservation. This past summer, thanks to IES and a National Science Foundation program called Research Experiences for Undergraduates (REU), they and eight other students were able to experience what research involves, from designing an experiment through presenting their data to scientific colleagues.

When information about this year's program was mailed to approximately 400 colleges and universities, Elizabeth Brozyna learned of the opportunity from one of her professors at Oberlin College in Ohio. She applied, was accepted, and received a list of project ideas prepared by the IES ecologists who served as mentors. Ms. Brozyna was particularly interested in a project that concerned competition between two species of snails living in the Hudson River. Upon arriving at IES late in May, she designed an experiment to try to learn why *Bithynia tentaculata,* introduced from Europe in the late 1700s, became more numerous than the native snail species, *Goniobasis virginica.* Was competition for nutrients an important factor?

Filter feeders are animals that eat small organisms or particles of organic matter that they strain out of the water. Ms. Brozyna's hypothesis was that *B. tentaculata* was more successful because it could graze and filter feed, while *G. virginica* could only graze. Filter feeding is particularly efficient in polluted waters, and as the Hudson River became more polluted there were more nutrients available for *B. tentaculata.* Ms. Brozyna set up her experiment in a light- and temperature-controlled chamber in the Institute's new rearing facility. Two large tanks were used, both containing the two snail species as well as sediments and aquatic plants on which they could graze. Algae were added to one of the tanks, to provide food for the filter feeding snails. Snail shells were marked with different colored nail polish for identification, and shell growth was measured over several weeks. While results from the experiment were not conclusive, Ms. Brozyna was able to make recommendations for improving methods should the experiment be done again.

Kimberly Shaffroth is a student at Ramapo College in Mahwah, New Jersey. After her acceptance into the REU Program, she became involved in a project to learn more about the function of woody debris in stream ecosystems. Scientific papers report that wood is important to fish. . . but why? Does the wood provide camouflage from predators? Or does it provide a home for the fish's prey?

Ms. Shaffroth made six one-meter square structures, each consisting of three crossed wooden beams fastened at the center. These structures were placed in the East Branch of Wappinger Creek at 5 meter (16.4 feet) intervals. Three were scrubbed every other day for 4 weeks to keep aquatic insects from moving in, while the other three were left alone. If fish congregated

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IES Summer, *from page 1*

near wood structures because of the food they provided, then Ms. Shaffroth would have expected to see more fish near the unscrubbed structures.

To monitor the fish's use of the structures, she periodically swam in the creek with mask and snorkel. She found five species of fish -- large mouth bass, brown trout, pumpkinseed sunfish, white suckers and fallfish minnow. Brown trout were the only fish that seemed to use the wood structure as a hiding place, and only bass appeared to show any preference for the unscrubbed over the scrubbed structures. Like Ms. Brozyna, Ms. Shaffroth learned about the scientific method from her summer's research, and if given the chance to repeat the study would look at other factors -- stream velocity, depth, existing cover -- to see how they contribute to the choice of habitat by the fish.

This was the second year that the National Science Foundation (NSF) awarded a grant to the Institute enabling undergraduate students to do independent research in collaboration with Institute ecologists. One of the goals of NSF is to assure an adequate supply of high quality scientists, mathematicians and engineers for the future, and an effective way to achieve this goal is to provide opportunities for college students to participate in research experiences.

To give the REU students as broad an exposure to science as possible, the Institute scheduled "Research in Context" seminars by IES and visiting scientists and "Research Strategies" presentations in which IES staff discussed techniques such as how to design ecological studies, how to analyze data and how to communicate results. Late in August, at a research symposium held in the Plant Science Building, each student presented data and results of his or her work. A collection of the students' papers will be available to the public as an IES Occasional Publication.

See page 4 for a list of 1989 REU students and projects.

Ozone Observations

True or false?: Ozone pollution is a city problem. Current research, including studies done at the Institute, prove the answer to be "False" — ozone pollution is present in the country as well. A demonstration prepared by the Institute's Public Education Program shows the effects of ozone pollution present in rural Dutchess County, New York. In the Air Pollution Garden, located at the Outdoor Science Center behind the Gifford House, project assistant Julia Kirtland set up a two-part exhibit: the Ozone Tolerance Test Garden and the Ozone Reduction Chambers.

In the Ozone Tolerance Test Garden, plants that are known to be tolerant of elevated ozone levels were grown side-by-side with those that are known to be sensitive. Morning glory, lilac, grape, aspen and milkweed were selected for the study, as these species have both ozone tolerant and sensitive varieties.

MICHAEL JOHN

Julia Kirtland tending tobacco and bushbeans in an Ozone Reduction Chamber.

The Ozone Reduction Chambers were large plastic enclosures in which ozone sensitive varieties of tobacco and bushbeans were grown. Two of the chambers had filtration systems that removed ozone from the air, while the other two chambers had unfiltered air pumped in. Two additional plots, without chambers, served as experimental controls.

Ozone pollution is generated by the reaction of sunlight with gaseous chemicals — nitrous oxides and hydrocarbons — that come from automobile exhaust and power generating plants. This reaction occurs silently and invisibly in the lower atmosphere. Local levels of ozone are highest when temperature and humidity soar and the winds are light but from a southerly direction, carrying ozone and its precursors from more polluted urban areas.

How does ground level ozone damage plants? Scientists speculate that the gas enters leaves through stomates — those microscopic pores on the leaf surface that allow the natural exchange of gases required for plant growth. Ozone then breaks down plant cell membranes, causing those cells to collapse. As more and more cells collapse, the leaves can no longer photosynthesize, thus limiting the health and growth of the plant.

Ozone levels during the long, hot summer of 1988 were high in the northeastern U.S., and during that time plants in the Air Pollution Garden showed typical signs of ozone damage: dark stippling (collection of pigment) or tan flecks (dead spots) on leaf surfaces, leaf yellowing and leaf fall. During this past summer, however, climatic conditions combined to keep ozone levels lower, and only the bushbeans grown in unfiltered air showed symptomatic stippling.

Funds for the IES Outdoor Science Center — the Air Pollution Garden, Acid Rain Study Ponds and an introductory walk-through pond ecosystem — have come from the Mary Flagler Cary Charitable Trust, the Millbrook Tribute Garden, the Natural Heritage Trust, the New York State Council on the Arts, and the Institute of Museum Services. The exhibits are closed for the winter but will reopen in spring 1990.

A note about ozone... Ozone that is generated from pollutant gases in the lower atmosphere — the ozone that is studied by IES scientists and educators — is potentially the most harmful air pollutant that we measure. However, ozone is naturally and beneficially formed in the upper atmosphere. There, in the stratosphere, the ozone layer filters out harmful ultraviolet radiation and protects living organisms on Earth from this radiation. It is this stratospheric ozone layer that is being depleted, especially in the region of the North and South Poles, by chlorofluorocarbon gases released into the atmosphere by, among other things, automobile air conditioners.

Visiting Scientist Series

Dr. Helge Leivestad: Acid rain, aluminum, and salmon

Acid rain, already suspected to be a problem in northern Europe, was first documented in North America by Dr. Gene E. Likens — now director of IES — in the early 1970s. At that time, few scientists understood much about the problem, and even fewer believed that acid rain could have any negative impact on fish and other aquatic organisms. Major survey projects were initiated in the Adirondack Mountains of New York, in Ontario and in Norway to evaluate the acidification of lakes and the extent of damage to fish populations. During project meetings, Dr. Likens met Dr. Helge Leivestad, a physiologist at the University of Bergen in Norway. The two continue to study the acid rain problem, and their scientific connection brought Dr. Leivestad to IES during a 1989 sabbatical leave.

Acid rain, which moves into Norway from areas to the south — primarily Great Britain and the European Continent — started killing salmon in the country's southern rivers during the 1930s. By the 1960s, salmon had disappeared entirely from these waters and more than 1,000 lakes had lost their brown trout populations. Norwegians were concerned, and sought scientific expertise to learn more about the nature of the problem.

Dr. Helge Leivestad is an associate professor of zoology. An expert on animal physiology, he became involved in acid rain research by applying his knowledge to the ways in which aquatic animals responded to chemical imbalances in their environments. During the 1970s, Dr. Leivestad was engaged by the Norwegian Acid Rain Project. His subsequent studies revealed that when the spring melt water was acid, aluminum concentrations in the water rose rapidly — and great numbers of fish died.

Normal soils have high mineral content, and when acidic water percolates through soil it releases these minerals. Aluminum is one of the minerals released, and it is an ecological paradox that this common element in soil can be so toxic to life. When dissolved aluminum enters the streams it affects the gills of fish, interfering with the exchange of materials between water and blood. The fish die quickly.

Fish are not physiologically adapted for sudden chemical changes, and Dr. Leivestad found that it was the sudden increase in dissolved aluminum levels that most affected them. That explains why the spring melt resulted in the highest mortality levels. He designed experiments in which he produced artificial spring melts to try to understand the different chemical forms of aluminum in nature, and to see which kinds are most toxic under which conditions. One form of aluminum, for example, is bound with humus — decayed plant matter — and this form is not at all toxic. How much aluminum is in that form? How much aluminum is dependent not only upon levels of acidity in water but also upon the composition of the soil and the water flow pattern in the soil? These are questions that have yet to be answered.

Smolt are seagoing salmon; after two years in freshwater streams, these young fish migrate to the ocean waters. Norwegian fish farmers transfer smolt to sea cages, and off the coast of Norway fish farming is a major industry: that nation produces 70% of the Atlantic salmon used world-wide. Since many of the smolt farms are situated in areas receiving acid rain, mortality caused by acid water has been a major problem in smolt farming. In the early 1980s, a research facility was built at a smolt farm outside Bergen, and there Dr. Leivestad has been studying the physiological effects of different water treatment regimes on the early life stages of Atlantic salmon.

With the knowledge that he has gained to date, Dr. Leivestad can recommend safe treatment procedures for water being released into tanks where young salmon are being raised, and can determine whether special filters are needed to remove aluminum. This ongoing study is an example of how a scientist can do pure research on a problem — *how* does something happen — while at the same time industry benefits by learning *what* can be done to solve a problem.

During his stay at the Institute, Dr. Leivestad is analyzing the data that he and his students have collected. He is also collaborating with scientists of the Hubbard Brook Ecosystem Study (the long-term project that led to Dr. Likens' acid rain discoveries) to compare data on water and soil relationships, and has shared his research results with colleagues and the public in seminars and the IES Sunday Ecology Program. When he returns to Norway, he will begin examination of fish gills to see how the cells and organs adapt to conditions of high acidity or high aluminum.

Note: In the humic rivers of Nova Scotia and Maine, Atlantic salmon are healthy in spite of very low pH levels resulting from acid rain. This is due to the chemical bonding reaction between humus and aluminum.*

* The logarithmic pH scale indicates degree of acidity or alkalinity. On the scale of 0-14, neutral is 7.0; ammonia, a base, has a pH of approximately 11.0 and vinegar, an acid, has a pH of approximately 3.0. The pH of "normal" rain is 5.6 or higher, while acid rain values range from approximately 5.0 down to 2.0 (the pH of lemon juice). Thus, the lower the pH value, the higher the acidity.

MICHAEL JOHN

Dr. Helge Leivestad (seated), on sabbatical leave at IES, studies the effects of acid rain and dissolved aluminum on salmon. Here he is visited by a colleague, Dr. Dagfinn Moe, also from the University of Bergen.

REU Students and Projects, 1989

(See the article on the IES summer, pages 1 and 2.)

Virginia M. Borden (University of Rochester, N.Y.): The effect of small mammal predators on late-instar gypsy moth survivorship. Mentor: Dr. C.G Jones.

Elizabeth Brozyna (Oberlin College, Oh.): Food resource competition between two freshwater prosobranch snails, *Bithynia tentaculata* and *Goniobasis virginica.* Mentors: Drs. T.S. Bianchi & D.L. Strayer.

Erin L. Connolly (Dartmouth College, N.H.): Light and water limitation on the growth of red maple seedlings transplanted into gray dogwood shrub communities. Mentor: Dr. A.R. Berkowitz.

John R. Cooley (Yale University, Ct.): Factors influencing tree seedling emergence in old fields. Mentor: Dr. S.T.A. Pickett.

Kristin Edelmann (Yale University, Ct.): Effects of ozone stress to cottonwood on resistance to leaf beetle oviposition. Mentor: Dr.Jones.

Robert F. Hopper (Cornell University, N.Y.): Defense induction and subsequent resource suitability in a cottonwood/leaf beetle model system. Mentor: Dr. Jones.

Jonathan A. Rosenfield (Cornell University, N.Y.): Nitrogen competition in *Andropogon scoparius* communities. Mentor: Dr. Berkowitz.

Kimberly Shaffroth (Ramapo College of New Jersey): Woody debris as fish habitat: Cover or prey resource. Mentors: Dr. S.E.G. Findlay and Dr. Strayer.

Tamara Szczesniak (University of Hartford, Ct.): Diel fluctuation of algal extracellular production and bacterial activity in Wappinger Creek. Mentors: Drs. Findlay and Strayer.

Joanna Wisniewski (Baldwin-Wallace College, Oh.): Heterogeneity and diversity — what is going on? Mentor: Dr. Pickett.

Fall/Winter Calendar

CONTINUING EDUCATION PROGRAM

Classes and workshops in landscape design, gardening and botany will begin in the third week of January. Continuing Education Program catalogues announcing winter and spring semester classes, workshops and ecological excursions will be available after mid-December.

Holiday Workshops... Call to preregister for:

Dec. 2 **All Seasons Wreath**
Dec. 9 **Topiary Tree with Greens**
Dec. 9 **Topiary Tree with Dried Materials**
Dec. 16 **Holiday Arrangement**

SUNDAY ECOLOGY PROGRAMS

Free public programs are offered on the first and third Sunday of each month, except over holiday weekends. Please call (914) 677-5359 to confirm the day's topic.

Dec. 3 **The Hubbard Brook Ecosystem Study**, slide presentation by Dr. Gene E. Likens
Dec. 17 — no program —
Jan. 7 Program to be announced
Jan. 21 **Weeds in Winter**, walk followed by indoor work with field guides and plant keys. Leader: Kass Hogan.
Feb. 4 Program to be announced
Feb. 17 — no program —

Programs begin at 2 p.m. at the Gifford House on Route 44A. For walks, dress according to the weather, with warm, waterproof footwear. In case of inclement weather, call (914) 677-5358 after 1 p.m. to learn the status of the day's program.

IES SEMINARS

The Institute's weekly program of scientific seminars features presentations by visiting scientists or Institute staff. All seminars are held in the Plant Science Building on Fridays at 3:30 p.m. Admission is free.

Dec. 1 **Biological Control of Bracken**, by Dr. John H. Lawton (Univ. of York, United Kingdom)
Dec. 8 **Nitrogen Saturation in Forest Ecosystems**, by Dr. John Aber (Univ. of New Hampshire)
Dec. 15 **Climatic Warming: Scientific Puzzle and Political Dilemma**, by Dr. George Woodwell (Woods Hole Research Center)
Jan. 12 **Limnetic Food Webs: Experimental Tests of Independence of Nutrient and Predator Controls**, by Dr. Stephen Threlkeld (Fordham Univ.)

GREENHOUSE

The IES greenhouse is a year-round tropical plant paradise as well as a site for controlled environmental research. The public is invited to visit the greenhouse during Arboretum hours. There is no admission fee, but visitors should first stop at the Gifford House for a free permit.

GIFT SHOP

Senior Citizens Days: On Wednesdays senior citizens receive a 10% discount on all purchases (except sale items).
Christmas Sale - 10% off all items: December 9, 10 am - 5 pm and December 10, 11:30 am - 5 pm.

ARBORETUM HOURS
(Winter Hours: October 1 - April 30; closed on public holidays.)

The **Arboretum** is open Monday through Saturday, 9 a.m. to 4 p.m.; Sunday 1 - 4 p.m. Internal roads and trails are closed during deer hunting season.
The **Gift and Plant Shop** is open Tuesday through Saturday 11 a.m. to 4 p.m. and Sunday 1 - 4 p.m. (closed weekdays from 1 - 1:30 p.m.).
All visitors must get a free permit at the Gifford House for access to the Arboretum. Permits are available up to one hour before closing time.

MEMBERSHIP

Become a member of the Mary Flagler Cary Arboretum. Benefits include a special member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, free subscriptions to the IES Newsletter and Garden (the beautifully illustrated magazine for the enterprising and inquisitive gardener), and parking privileges and free admission to the Enid A. Haupt Conservatory at The New York Botanical Garden in the Bronx. Individual membership is $30; family membership is $40. For information on memberships, contact Janice Claiborne at (914) 677-5343.

For more information, call (914) 677-5359 weekdays from 8:30 - 4:30

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